Tunable Dielectric Composite Thick Films And Methods Of Making Same"; U.S. Pat. No. 6,617,062 entitled "Strain-Relieved Tunable Dielectric Thin Films"; U.S. Pat. No. 6,905,989, filed May 31, 2002, entitled "Tunable Dielectric Compositions Including Low Loss Glass"; U.S. patent application Ser. No. 10/991,924, filed Nov. 18, 2004, entitled "Tunable Low Loss Material Compositions and Methods of Manufacture and Use Therefore" These patents and patent applications are incorporated herein by reference.

The tunable dielectric materials can also be combined with one or more non-tunable dielectric materials. The non-tunable phase(s) may include MgO, $MgAl_2O_4$, $MgTiO_3$, Mg_2SiO_4, $CaSiO_3$, $MgSrZrTiO_6$, $CaTiO_3$, Al_2O_3, SiO_2 and/or other metal silicates such as $BaSiO_3$ and $SrSiO_3$. The non-tunable dielectric phases may be any combination of the above, e.g., MgO combined with MgTiO3, MgO combined with $MgSrZrTiO_6$, MgO combined with Mg_2SiO_4, MgO combined with Mg_2SiO_4, Mg_2SiO_4 combined with $CaTiO_3$ and the like.

Additional minor additives in amounts of from about 0.1 to about 5 weight percent can be added to the composites to additionally improve the electronic properties of the films. These minor additives include oxides such as zirconates, tannates, rare earths, niobates and tantalates. For example, the minor additives may include $CaZrO_3$, $BaZrO_3$, $SrZrO_3$, $BaSnO_3$, $CaSnO_3$, $MgSnO_3$, $Bi_2O_3/2SnO_2$, Nd_2O_3, Pr_7O_{11}, Yb_2O_3, Ho_2O_3, La_2O_3, $MgNb_2O_6$, $SrNb_2O_6$, $BaNb_2O_6$, $MgTa_2O_6$, $BaTa_2O_6$ and Ta_2O_3.

Films of tunable dielectric composites may comprise $Ba_{1-x}SrxTiO_3$, in combination with at least one non-tunable dielectric phase selected from MgO, $MgTiO_3$, $MgZrO_3$, $MgSrZrTiO_6$, Mg_2SiO_4, $CaSiO_3$, $MgAl_2O_4$, $CaTiO_3$, Al_2O_3, SiO2, BaSiO3 and SrSiO3. These compositions can be BSTO and one of these components, or two or more of these components in quantities from 0.25 weight percent to 80 weight percent with BSTO weight ratios of 99.75 weight percent to 20 weight percent.

The electronically tunable materials may also include at least one metal silicate phase. The metal silicates may include metals from Group 2A of the Periodic Table, i.e., Be, Mg, Ca, Sr, Ba and Ra, preferably Mg, Ca, Sr and Ba. Preferred metal silicates include Mg2SiO4, CaSiO3, BaSiO3 and SrSiO3. In addition to Group 2A metals, the present metal silicates may include metals from Group 1A (alkalai metals), i.e., Li, Na, K, Rb, Cs and Fr. For example, alkalai metal silicates may include sodium silicates such as Na2SiO3 and NaSiO3-5H2O, and lithium-containing silicates such as LiAlSiO4, Li2SiO3 and Li4SiO4. Metals from Groups 3A, 4A and some transition metals of the Periodic Table may also be suitable constituents of the metal silicate phase. Additional metal silicates may include Al2Si2O7, ZrSiO4, KalSi3O8, NaAlSi3O8, CaAl2Si2O8, CaMgSi2O6, BaTiSi3O9 and Zn2SiO4. The above tunable materials can be tuned at room temperature by controlling an electric field that is applied across the materials.

In addition to the electrically tunable dielectric phase, the electrically tunable materials can include at least two additional metal oxides. The additional metal oxides may include alkalai earth metals from Group 2A of the Periodic Table, i.e.; Mg, Ca, Sr, Ba, Be and Ra. The additional metal oxides may also include metals from Group 1A, i.e., Li, Na, K, Rb, Cs and Fr, preferably Li, Na and K. Metals from other Groups of the Periodic Table may also be suitable constituents of the metal oxide phases. For example, refractory metals such as Ti, V, Cr, Mn, Zr, Nb, Mo, Hf, Ta and W may be used. Furthermore, metals such as Al, Si, Sn, Pb and Bi may be used. In addition, the metal oxide phases may comprise rare earth metals such as Sc, Y, La, Ce, Pr, Nd and the like.

The additional metal oxides may include, for example, zirconates, silicates, titanates, aluminates, stannates, niobates, tantalates and rare earth oxides. Preferred additional metal oxides include MgO, CaO, ZrO_2, Al_2O_3, WO_3, SnO_2, SnO_2 Ta_2O_5, MnO_2, PbO, Bi_2O_3 and La_2O_3 (or any other rare earth oxide) in any concentration

Multilayer capacitors with different biasing methods have been described in other patents assigned to Gennum Corporation; U.S. Pat. No. 5,745,335 and U.S. Pat. No. 6,411,494. These patents are applicable to the multi-layered structures described in this invention.

What is claimed is:

1. A device, comprising:

a multilayered tunable dielectric capacitor, wherein said multilayers of tunable dielectric are adapted to be DC biased to reduce the dielectric constant; and

wherein said DC bias is arranged so that the number of layers of tunable dielectric biased positively is equal to the number of layers of tunable dielectric biased negatively.

2. The device of claim **1**, wherein said multilayers are an even number of layers.

3. The device of claim **2**, wherein said even number of layers is 2.

4. The device of claim **3**, wherein said two layers produce acoustic waves of the opposite phase which cancel.

5. The device of claim **3**, further comprising a center plate and two outer plates defining the two layers and wherein a DC voltage is applied from the center plate to the outer two plates and wherein the DC is capable of being either positive or negative.

6. The device of claim **5**, wherein the addition of a DC bias causes said two tunable layers to vibrate in response to an RF signal and said center plate electrode will vibrate while said outer electrodes are still.

7. The device of claim **1**, wherein by placing a first capacitor layer on top of at least one additional capacitor layer and sharing a common electrode in between the two, the vibration of said first layer is coupled to a corresponding antiphase vibration of said at least one additional layer.

8. The device of claim **1**, wherein each layer of the tunable dielectric is isolated from another layer of the tunable dielectric by an electrode.

9. The device of claim **8**, wherein said tunable dielectric material comprises barium strontium titanate (BST).

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